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Final Technical Report to

The Upper Atmosphere Research Programs Office

of the

National Aeronautics and Space Administration

for

Far-infrared Measurements of Trace Gases

NASA Grant NSG 7360

to

Department of Physics
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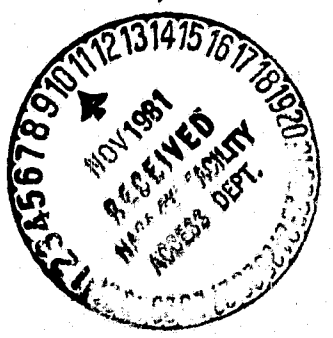

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SUMMARY

Our basic objective in this program was to determine the applicability of far-infrared emission spectroscopy for the measurement of critical atmospheric trace gases. The University of Oregon effort benefitted greatly by working in a collaborative effort with the European-based Sub-millimeter Infrared Balloon Experiment (SIBEX) program which in the course of this effort obtained the first high resolution ($\Delta\nu \simeq 0.003$ cm^{-1}) emission spectra of the stratosphere emission. The following two major objectives were accomplished: (1) The University of Oregon completed its development of a better detector system for far-infrared spectroscopy. (2) Important technical assistance was provided to the two SIBEX balloon flights which demonstrated the diagnostic capability of far-IR emission spectroscopy. As a result the next SIBEX instrument flights will be upgraded with new improved detectors.

The program's major success has clearly been its definitive demonstration of broad-band IR detectors with approximately an order-of-magnitude increase in sensitivity than previously available. Current work is underway to provide these improved detectors for the next SIBEX instrument flights in 1982/83 (NASA NAGW-222). The detector development done in this program is also having a major spin-off impact in other areas, such as continuum millimeter radio astronomy and fusion diagnostics.

I. Work Accomplished

1. Detector Development

At the beginning of this program (September 1977) the University of Oregon had demonstrated a new cryogenic technology for cooling bolometric detectors to ~0.4K (Radostitz et. al. 1978). In 1978-79 this system development was completed and a study of experimental performances showed that this type of detector provided an approximate order-of-magnitude improvement in sensitivity. (S. el-Atawy et. al. 1980).

The detector research carried out in this program has had a major impact to other infrared applications as well. Important spin-off applications of this technology are being made to millimeter radio astronomy and to the search for fast response detectors for fusion diagnostics. A separate listing of related research in the next section identifies some of the current work in other fields spawned by the catalytic detector research done in this program.

2. Upper Atmosphere Spectroscopy

The long term objective is the application of far-IR spectroscopy to the measurement of stratospheric trace gases. The European-based SIBEX program has the same objectives so it has been extremely beneficial to work closely together. The University of Oregon provided help with the launch and instrument preparations for the two SIBEX launches from Palestine, Texas, in 1978/79. The spectroscopic results obtained in this program have shown a spectacularly rich spectral structure in the stratosphere emission. It is estimated that more than a hundred spectral emission features have been detected which are not due to the main emitting gases O_3, O_2, and H_2O (Carli et. al. 1980). The trace species sources for many features still remain unidentified and the spectra thus present a new source of information on the stratospheric composition.

The SIBEX launch program was assisted in a substantial way by this University of Oregon program. Further work is currently underway to incorporate the new type of Oregon detectors into the SIBEX experiment for the 1982/83 balloon flights under a new NASA grant to the University of Oregon(NAGW-222).

II. Publications and Papers Presented

1. "Optimization of Spectral Signal-to-Noise in Interferometric Measurements of Atmospheric Emission Lines", I.G. Nolt , Invited paper presented at Third Int'l Conference on Sub-Millimeter Waves, Guildford, U.K., 1978. (no manuscript).

2. "Evaluation of Composite Bolometers at 0.4 Kelvin", S. el-Atawy, P.A.R. Ade, J.V. Radostitz, and I.G. Nolt, Int'l J. of Infrared and Millimeter Waves, 1, 459, 1980.

3. "A Portable He-3 Detector Cryostat for the Far-infrared", J.V. Radostitz, I.G. Nolt, P. Kittel, and R.J. Donnelly, Rev. Sci. Instruments, 49, 86, 1978.

Additional Publications and Papers which relate to this work or represent subsequent spin-off applications.

1. "Fourier Spectroscopy of the Stratospheric Emission", B. Carli, F. Mencaraglia, and A. Bonetti, Int'l J. Infrared and Millimeter Waves, 1, 263, 1980 .

2. "A 0.4K Bolometer Receiver for Millimeter Astronomy", P. Ade, J. Davis, I. Nolt, J. Payne, S. Predko, and J. Radostitz, to be presented at Sixth Int'l Conference on IR and Mm Waves, December 1981.

3. "Tests of Fast Bolometers for Near-Millimeter Fusion Applications", P. Ade, D. Boyd, I. Nolt and J. Radostitz, to be presented at Sixth Int'l Conference on IR and Mm Waves, December 1981.

4. "He-3 Bolometer Cryostat Design for Telescopes", I. Nolt, P. Ade, J. Davis, S. Predko, and J. Radostitz, to be presented at URSI Nat'l Radio Science Meeting, January 1982.

5. "The NRAO 0.4K Bolometer Receiver System for Millimeter Continuum Observations", J. Payne, J. Radostitz, S. Predko, I. Nolt, R. Howard, J. Davis, and P. Ade, to be presented at URSI Nat'l Radio Science Meeting, January 1982.